UNIVERSITI SAINS MALAYSIA

First Semester Examination
2011/2012 Academic Session

January 2012

EKC 271 – Biotechnology for Engineers
[Bioteknologi untuk Jurutera]

Duration : 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of SIX pages of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi ENAM muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

Instruction: Answer **ALL** (4) questions.

*[**Arahan:** Jawab **SEMUA** (4) soalan.]*

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]

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Answer ALL questions.
Jawab SEMUA soalan.

1. [a] Glycolysis is a partial breakdown of a six-carbon glucose molecule into two, three-carbon molecules of pyruvate, 2NADH + $2H^+$, and 2 net ATP as a result of substrate-level phosphorylation.

Glikolisis adalah pemecahan separa molekul glukosa enam-karbon kepada dua molekul, tiga-karbon piruvat, 2NADH + $2H^+$, dan 2 ATP bersih hasil daripada fosforilasi paras substrat.

[i] Which reactions require and produce ATP? List the enzymes involved.

Tindak balas manakah yang memerlu dan menghasilkan ATP? Senaraikan enzim yang terlibat.

[ii] Which reactions require NADH or NAD^+? What is/are the enzymes involved and their origin?

Tindak balas manakah yang memerlukan NADH atau NAD^+? Apakah enzim yang terlibat dan dari manakah asalnya?

[iii] In anaerobic condition, glycolysis occurs through 2 biochemical pathways in which the enzymes alcohol dehydrogenase and lactate dehydrogenase took part. State the similarity of these two enzymes.

Dalam keadaan anaerob, glikolisis berlaku melalui 2 laluan biokimia, di mana enzim alkohol dehidrogenase dan laktat dehydrogenase mengambil bahagian. Nyatakan persamaan bagi kedua-dua enzim ini.

[iv] What is the net gain of ATP molecules derived from the reactions of glycolysis?
Apakah perolehan bersih bagi molekul ATP hasil daripada tindak balas glikolisis?

[v] What are the possible metabolic fates of pyruvate?
Apakah kemungkinan kesudahan metabolik bagi piruvat?

[10 marks/markah]

[b] A few hikers of USM to Mount Tahan could go directly down a steep slope but find difficulties to climb back up the hill by an alternative, easier route. Under such condition, three (3) by-pass steps in the biological pathways are involved.

Beberapa pendaki USM ke Gunung Tahan berjalan terus menuruni kecerunan yang tajam tetapi mengalami kesusahan untuk mendaki semula gunung dengan jalan alternatif yang lebih mudah. Dalam keadaan begini, tiga (3) langkah pirau di dalam laluan biologikal terlibat.

[i] What are the three (3) by-pass steps in the biological pathways, showing the enzymes and cofactors that take place?

Apakah (3) langkah pirau di dalam laluan biologikal, dengan menunjukkan enzim dan kofaktor yang terlibat.

[ii] If one of the hikers has muscular aches due to strenuous exercise, CORI cycle will be involved to solve his/her problems. Explain the concept of CORI cycle.

Jika seorang daripada pendaki mengalami kecederaan otot akibat latihan yang intensif, kitaran 'CORI' akan terlibat untuk menyelesaikan masalah itu. Terangkan konsep kitaran 'CORI'.

[10 marks/markah]

[c] Write short notes on the followings:
Tuliskan nota-nota ringkas bagi yang berikut:

[i] chromosome
kromosom

[ii] gene
gen

[iii] codon
kodon

[iv] chloroplast
kloroplas

[v] mutant duplication
duplikasi mutan *[5 marks/markah]*

2. [a] State the effects of sterilization on mixing in a batch bioreactor.

Nyatakan kesan pensterilan ke atas percampuran di dalam bioreaktor kelompok. *[5 marks/markah]*

[b] For the inactivation of *B. subtilis* spores, $A = 9.5 \times 10^{37}$ min^{-1}, and $E = 68.7$ kcal/mol. Assuming that a liquid containing these spores is instantaneously sterilized at 115°C, calculate the time required to give a destruction ratio of 10^6.

Untuk ketidakaktifan spora B. subtilis, $A = 9.5 \times 10^{37}$ min^{-1}, *dan* $E = 68.7$ *kkal/mol. Andaikan cecair itu mengandungi spora yang boleh disteril dengan serta merta pada 115°C, kirakan masa yang diperlu untuk menghasilkan nisbah kemusnahan* 10^6. *[5 marks/markah]*

[c] During the batch sterilization of a liquid media, normally carried out at 121°C for 10 min, the control system showed a malfunctioned when the temperature reached 116°C. Due to the malfunction, the temperature remained at 116°C for 15 min before the fault was rectified.

Semasa pensterilan kelompok bagi cecair media yang dijalankan pada 121 °C selama 10 minit, sistem pengawalan menunjukkan kerosakan apabila suhu mencecah 116°C. Akibat daripada kerosakan itu, suhu kekal pada 116°C selama 15 minit sebelum kerosakan dikenalpasti.

[i] What new holding time at 121°C will be required to ensure that the design criterion (▼) is maintained for this batch?

Apakah masa penahanan yang baru pada 121 °C diperlukan supaya kriteria rekabentuk (▼) *bagi kelompok ini dapat disenggarakan?*

[ii] If the liquid media contains vitamins and suspended solids, explain how the sterilization can be carried out.

Sekiranya cecair media ini mengandungi vitamin dan pepejal ampaian, jelaskan bagaimana pensterilan boleh dilakukan. *[8 marks/markah]*

[d] During intense activity, Sara, one of the top ranking tennis players felt difficulty in breathing. The Red Crescent paramedics gave an oxygen supply so that she could breathe easily.

Semasa aktiviti intensif, Sara, seorang daripada pemain tenis yang berkedudukan teratas mengalami kesukaran untuk bernafas. Pasukan paramedik Bulan Sabit Merah memberi bekalan oksigen supaya beliau boleh bernafas dengan mudah.

Briefly describe the metabolic pathways involved during such activities that the athlete tries to cope. Is there any relation with the CORI cycle?

Jelaskan laluan metabolik yang terlibat semasa aktiviti tersebut yang membolehkan beliau dapat bertahan. Adakah ianya berkaitan dengan kitaran 'CORI'? *[7 marks/markah]*

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3. [a] Several phases of cell growth are observed in a batch culture of a bacteria cells such as *Rhodospirillum*.

Beberapa fasa tumbesaran sel diperhatikan di dalam satu kelompok kultur sel-sel bakteria seperti Rhodospirillum.

[i] Sketch a typical growth curve for the cell growth and label the different phases.
Lakarkan keluk tumbesaran tipikal bagi tumbesaran sel dan labelkan perbezaan fasa.

[ii] With the aid of relevant equations, explain the characteristics of each phases.
Dengan bantuan persamaan yang berkaitan, jelaskan ciri-ciri setiap fasa. *[12 marks/markah]*

[b] A strain of mold was grown in a batch culture on sucrose and the following data were obtained.

Sejenis kulat telah ditumbuhkan di dalam kultur kelompok mengandungi sukrosa dan data berikut telah diperolehi.

Time (h) *Masa (jam)*	Cell concentration *Kepekatan sel* (g/L)	Sucrose concentration *Kepekatan sukrosa* (g/L)
0	1.25	100
9	2.45	97
16	5.1	90.4
23	10.5	76.9
30	22	48.15
34	33	20.6
36	37.5	9.38
40	41	0.63

[i] Calculate the maximum growth rate.
Kirakan kadar tumbesaran yang maksima.

[ii] Calculate the substrate yield.
Kirakan hasil substratum.

[iii] What is the maximum cell concentration one could expect if 150 g of sucrose was used with the same size inoculum?
Apakah kepekatan sel maksima jika 150 g sukrosa digunakan dengan inokulum yang sama saiz? *[13 marks/markah]*

4. [a] Write short notes on the following methods of enzyme immobilization:

Tuliskan nota ringkas kaedah-kaedah berikut bagi enzim yang tersekat gerak:

[i] adsorption
jerapan

[ii] covalent binding
ikatan kovalen

[iii] matrix entrapment
perangkap matrik

[iv] membrane entrapment
perangkap membran *[12 marks/markah]*

[b] The hydration of CO_2 is catalyzed by carbonic anhydrase as follows:
Penghidratan CO_2 dimangkinkan oleh karbonik anhidrase seperti di bawah:

$$H_2O + CO_2 \overset{E}{\rightleftharpoons} HCO_3^- + H^+$$

The following data were obtained for the forward and reverse reaction rates at pH 7.1 and carbonic anhydrase concentration of 2.8×10^{-9} M.

Data berikut telah diperolehi bagi kadar tindak balas ke depan dan berbalik pada pH 7.1 dan kepekatan karbonik anhidrase adalah 2.8 x 10^{-9} M.

Hydration *Penghidratan*		Dehydration *Penyahidratan*	
$1/v$, M^{-1} (s x 10^{-3})	(CO_2) (M x 10^3)	$1/v$, M^{-1} (s x 10^{-3})	(HCO_3^-) (M x 10^3)
36	1.25	95	2
20	2.5	45	5
12	5	29	10
6	20	25	15

v is the initial reaction rate at the given substrate concentration. Calculate the forward and reverse catalytic and Michaelis constants.

v adalah kadar tindak balas permulaan pada kepekatan substratum yang diberikan. Kirakan pemalar pemangkin dan Michaelis untuk tindak balas ke depan dan berbalik.

[13 marks/markah]

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